Remarks/Arguments:

This amendment is in response to the Office Action dated July 6, 2006. Also enclosed is a petition for a three-month extension of time in accordance with 37 CFR 1.136(a). Submitted concurrently are an executed Power of Attorney form and a Statement under 3.73(b), which empower the undersigned to prosecute this application. Entry of this Amendment and reconsideration of this application are respectfully requested.

Applicant acknowledges the Examiner's determination that claims 1, 6, 7 and 10-12 are pending in the present application, and that claims 2-5, 8-9 and 13-26 are withdrawn pursuant to 37 CFR 1.142(b).

Rejection of claims under 35 USC 103(a)

Claims 1, 6-7 and 10-12 were rejected as obvious over a patent publication by Gasser et al. ("Gasser") in combination with a patent issued to Payne ("Payne").

In response, claim 1 has been amended to better clarify the differences present between the claimed device and the cited art. As amended, claim 1 is directed to a tunable optical filter for transmitting light in a band of wavelengths centered about a bandpass wavelength that is tunable over a second wider band. The filter comprises:

- first and second reflectors held in substantially parallel alignment and separated by a variable air gap;
- a partitioned cavity including:
    - a first dielectric layer on the first reflector,
    - the variable air gap, and
    - a second dielectric layer on the second reflector,
- the partitioned cavity having:
    - an effective optical thickness substantially equal to an integral multiple of one half of the filter's bandpass wavelength, and
    - an effective refractive index greater than one;
- the first and second dielectric layers each having an optical thickness less than one fourth of the shortest wavelength within the second wider band; and
- a tuning mechanism for moving at least one of said reflectors to vary the air gap and tune the bandpass wavelength;

- the filter having an associated transmission spectrum which shifts to shorter wavelengths as the angle of incidence (θ) of light impinging on the filter increases from normal incidence, the partitioned cavity arranged such that the magnitude of the shift for a given θ is less than it would be for a filter having a cavity consisting solely of an air gap.

The primary objective of the claimed optical filter is to provide a filter that "is less sensitive to angle of incidence and thus suitable for use in optical imaging systems having lower f-number and hence greater light gathering power" (page 4, lines 26-29). This is achieved by replacing the air gap cavity used in conventional designs with a partitioned cavity having very specific characteristics. Claim 1 requires that the partitioned cavity include:

- first and second dielectric layers on the first and second reflectors, respectively - each having an optical thickness less than one fourth of the shortest wavelength within the second wider band (i.e., the frequency band over which the filter may be tuned); and
- a variable air gap;
- the partitioned cavity having:
    - an effective optical thickness substantially equal to an integral multiple of one half of the filter's bandpass wavelength, and
    - an effective refractive index greater than one.

Claim 1 has been amended to note that the filter has an associated transmission spectrum which shifts to shorter wavelengths as the angle of incidence (θ) of light impinging on the filter increases from normal incidence, and to <u>explicitly require</u> that the filter's partitioned cavity be arranged to achieve the applicants' objective of reducing the magnitude of the wavelength shift for a given θ when compared with a filter having a cavity consisting solely of an air gap. When configured as specified in the amended claim 1, the partitioned cavity provides an effective refractive index (n_{eff}) greater than one; this is desirable, as the angle dependence decreases with increasing n_{eff}. The effective value of n_{eff} when using the specified partitioned cavity is roughly given by the thickness-weighted average of the refractive indices of the three layers (dielectric, air, dielectric). Air has a refractive index of 1.0. Thus, employing dielectric layers with refractive indices greater than one enables the n_{eff} of the three layers to be greater than one. As noted on page 8, at lines 6-8: "[t]he higher

refractive index reduces the angle of the light θ_c within the cavity layer, which in turn reduces wavelength shift and spectral broadening." As further explained on page 9, lines 4-9, "[a]s the [variable air] gap shrinks [via the tuning mechanism], the effective refractive index of the partitioned cavity increases as the relative contribution of the partitioned cavity dielectric layers increases. This has the effect of modifying the wavelength vs. cavity thickness relationship as well as further reducing the filter's angle sensitivity as the air gap is reduced."

The cited art is quite different. It should first be noted that the Gasser publication describes a structure having a completely different objective than that of the applicants. Gasser provides a silicon nitride (Si_3N_4) coating (13,14) on his opposing mirrors (9,12), the sole purpose of which is to prevent corrosion of the metal mirrors (Abstract).

As best as can be understood, Gasser's Si_3N_4 coating is very thin - about 20 nm (see column 3, lines 4-8). Such a thin layer is to be expected, since a thicker layer provides no advantage with respect to the coating's anti-corrosion purpose. As explained below, a 20 nm coating as taught by Gasser would typically have a negligible effect on effective refractive index, and thus the Gasser filter fails to provide the functionality specified in the amended claim 1.

The application wavelength for this filter is ~700 nm. Silicon nitride has a refractive index (n) of ~2.0, so the optical thickness of a 20 nm thick film is 40 nm. The thickness of a quarter-wave layer is given by:

$D = \lambda/4n$

Thus, a quarter-wave of Si_3N_4 at 700 nm will be ~87 nm, so the 20 nm anti-corrosion layer is only about 1/16 wave, which would have a very limited effect on the relationship between wavelength shift and θ.

Gasser's Si_3N_4 layers are extremely thin relative to the operating wavelength (and hence total optical thicknesses of the cavity). Therefore, they have an extremely limited effect on reducing angle shifts. This becomes more pronounced for filters having longer wavelengths. For example, such a coating would have essentially <u>no</u> effect on the relationship between wavelength shift and θ for a filter designed with a passband in the IR portion of the spectrum. For example, consider a LWIR filter application having a passband centered around a wavelength of ~10 μm (10,000 nm). Since Gasser's Si_3N_4 coating is intended solely to prevent corrosion, its thickness would be no greater than that required for a 700 nm filter -

i.e., 20 nm. However, for this 10 μm filter, a quarter-wave of Si_3N_4 would have to be 1250 nm thick. The 20 nm Si_3N_4 anti-corrosion film would be a miniscule fraction of a quarter-wave, and an even smaller fraction of the minimal cavity spacing. Assuming the shortest filter wavelength is 8.0 μm, the filter gap (ignoring the dielectric film) would be 4.0 μm (half wave). Thus, a 20 nm Si_3N_4 film would be only 0.5% of the filter gap. Even if the films were twice as thick as that taught by Gasser - i.e., two films with an optical thickness of 40 nm each - this would correspond to only 2% of the optical thickness of the filter gap. Using a film of this thickness would have a <u>negligible effect</u> on the effective refractive index of the filter cavity, and would therefore have an imperceptible impact on the relationship between wavelength shift and θ. And since Gasser's Si_3N_4 film is used for the sole purpose of corrosion prevention, there would be no motivation to increase the thickness of the Si_3N_4 layers as would be necessary for a longer wavelength filter.

It was the applicants who determined that providing a partitioned cavity in accordance with the amended claim 1 would reduce the magnitude of wavelength shift for a given θ. Gasser neither discloses nor suggests this functionality. The Si_3N_4 coating of Gasser is intended for a completely different purpose (corrosion prevention) than that provided by the dielectric layers recited in claim 1, and provides a structure that would have little to no effect on the relationship between wavelength shift and θ for most optical filters. As such, there is no basis for concluding that the teachings of Gasser would have lead one of ordinary skill in the art to the applicants' partitioned cavity structure and its effects on the filter's optical performance. The patent to Payne says nothing about dielectric layers or wavelength shift, and does nothing to overcome the shortcomings of Gasser. As such, the applicants assert that the filter recited in the amended claim 1 would <u>not</u> have been obvious at the time the invention was made in view of Gasser and Payne.

The amended claim 1 is the parent of claims 6-7 and 10-12, which should therefore be allowable along with claim 1.

<u>New claims</u>

Three new claims have been added - claims 27-29. Each depends from the amended claim 1, and thus should be allowable along with that claim.

Claim 27 specifies that the filter is arranged such that its bandpass wavelength is tunable within a range of 3-12 microns, and claim 28 specifies a range of 8-12 microns. Support for these claims is found in the specification at, for example, page 13, lines 22-29. As noted in the example given above, a Si_3N_4 coating as taught by Gasser would have essentially no impact whatsoever on the relationship between wavelength shift and θ for filters designed with passbands within these IR wavelengths.

Claim 29 specifies that the partitioned cavity provides an effective refractive index (n_{eff}) of greater than two. This finds support in the specification on page 10, at lines 10-13 ($n_{eff} \approx 2.5$), and in FIG. 3 (n_{eff} up to 4.0). As noted above, the effective value of n_{eff} is roughly given by the thickness-weighted average of the refractive indices of the three layers. Air has a refractive index of 1.0, and Si_3N_4 has a refractive index of ~2.0. As a result, n_{eff} for Gasser's cavity can be no greater than 2.0, and would be considerably less than 2.0. In fact, assuming a usable air gap, Gasser's effective refractive index would be only marginally greater than one, and would have no practical effect on angle properties. To have $n_{eff} > 2$ and still have tunability (using an air gap with n=1), requires dielectric layers that have a refractive index significantly greater than 2.0.

Claim 30 is a new independent claim that includes limitations directed to the filter's operating range (3-12 microns), and effective refractive index ($n_{eff} > 2$), which clearly distinguish it from the cited art.

All of the claims presently in the application are believed to be patentably distinct with respect to the cited art and to otherwise be in proper form for allowance. A Notice of Allowance is respectfully requested.

Very truly yours,

[signature]

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